FEASIBILITY OF USING THE 'SPACING EFFECT' AS PART OF AN INTERVENTIONAL STRATEGY TO CURB OVERWEIGHT AND OBESITY AMONG YOUNG ADULTS IN SUNGAI PETANI, KEDAH, MALAYSIA

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by

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DEDICATION

Dedicated to the erstwhile fallen, the abandoned, the outcasts, and the *les miserables,* who arose yet again like the proverbial phoenix above the scorching flames of injustice, suppression, oppression, and the like.

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'The LORD is my rock, my fortress and my deliverer; my God is my rock, in whom I take refuge, my shield and the horn of my salvation, my stronghold'.

- *Psalms 18:2*

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
AV	Audio-Visual
BMI	Body Mass Index
BWMPs	Behavioral Weight Management Programs
C	Control group
CDC	Centre for Disease Control and prevention
CI	Confidence Interval
CVDs	Cardiovascular Diseases
D	Diet group
DEXA	Dual-Energy X-ray Absorptiometry
DSM-IV-TR	Diagnostic and Statistical Manual of Mental Disorders
E	aerobic Exercise group
P-I	Phase I
P-II	Phase II
P-III	Phase III
GIS	Global Index System
ICF	Informed Consent Form
IOTF	International Obesity Task Force
IQR	Inter Quartile Range
Kg	Kilograms
MoH	Ministry of Health

LTM	Long-Term Memory
LTP	Long-Term Potentiation
MeSH	Medical Subject Headings
NHLB	National Heart, Lung and Blood Institute
NHMS	National Health and Morbidity Survey
NMRR	National Medical Research Register
NICE	National Institute for Health and Clinical Excellence
NIDDM	Non-insulin dependent diabetes mellitus
NCDs	Non-Communicable Diseases
PA	Physical Activity
PALs	Physical Activity Levels
P1, P2, and P3	Phase-I, Phase-II, and Phase-III (respectively)
RI	Retention Interval
SES	Socio-economic status
SEM	Socio-economic model
TV	Television
WHO	World Health Organization

KEBOLEHLAKSANAAN MENGGUNAKAN 'SPACING EFFECT' SEBAGAI SUATU STRATEGI BAGI MENGEKANG BERAT BADAN BERLEBIHAN DAN OBESITI DALAM KALANGAN BELIA DI SUNGAI PETANI, KEDAH, MALAYSIA

ABSTRAK

Berat badan berlebihan dan obesiti di takrifkan sebagai suatu keadaan yang dicirikan oleh lemak badan berlebihan yang memberikan impak kesihatan negatif. Bilangan individu yang mempunyai berat badan berlebihan semakin bertambah di Malaysia walaupun pelbagai usaha melalui kempen-kempen kesihatan awam. Epidemik ini telah memberi kesan ke atas bilangan dewasa muda, berumur antara 18 hingga 30 tahun. Intervensi-intervensi yang bertujuan mendidik masyarakat berkaitan impak negatif berat badan berlebihan dan/atau obesiti tidak berjaya sepenuhnya mengekang isu ini. Suatu kajian eksploratori, prospektif dan deskriptif telah dilakukan kalangan sampel wakilan berat badan berlebihan dan individu obes di Sungei Petani. Objektif utama kajian ini adalah untuk meninjau ketersauran menggunakan suatu teknik baru yang dikenali sebagai 'spacing effect atau spaced repetition' sebagai antara strategi intervensi dalam mengekang isu berat badan berlebihan dan obesiti. Kajian ini melibatkan tiga fasa dengan sela intervensi enam bulan antara setiap fasa. Instrumen kajian ini merangkumi penggunaan pra-pengesahan, soal selidik untuk menilai skor responden dalam tiga domain (pengetahuan, tabiat diet dan aktiviti fizikal) dan risalah pendidikan untuk memberikan pengetahuan mengenai ketiga-tiga domain bagi meningkatkan pengetahuan responden. Perubahan dalam skor bagi setiap domain dapat ditunjukkan dengan pengurangan dalam berat badan dan BMI bagi sampel wakilan. Pada fasa permulaan,

sebanyak 115 wakilan lelaki dan 450 wakilan wanita terlibat dalam kajian ini. Berat badan, BMI, pengetahuan, tabiat pemakanan dan aktiviti fizikal telah didapati bertambah baik sepanjang perjalanan kajian ini. Pada akhir fasa 3 (P3), berat (median) menurun sebanyak 7 kg. dengan penurunan sepadan BMI daripada 26.67 pada fasa 1 (P1) kepada 24.24 pada P3 kalangan responden-responden. Skor responden dalam semua domain juga menunjukkan peningkatan signifikan. Nilai peratusan menunjukkan penurunan berat dan BMI serta peningkatan dalam ketiga-tiga domain yang dinilai. Perbandingan antara P3 dan P1 bagi meningkatnya nilai peratusan dalam pengetahuan, tabiat diet, aktiviti fizikal, skor keseluruhan, berat dan BMI adalah 35.0, 43.33, 17.85, 35.71, 10.0 dan 9.11 bagi setiap satunya. Gred skor responden bagi parameter yang sama juga menunjukkan peningkatan dalam gred 'sederhana' dan ' baik' pada P2 dan meningkat kepada gred 'baik'dalam P3, manakala jumlah gred ' lemah' yang tinggi pada permulaan kajian telah menurun dengan mendadaknya pada akhir P3. Kesimpulan, kajian ini menunjukkan bahawa penggunaan teknik 'spacing effect' boleh laksana bagi meningkatkan pengetahuan yang seterusnya memberikan impak positif terhadap tabiat diet, aktiviti fizikal, berat dan BMI responden-responden.

FEASIBILITY OF USING THE 'SPACING EFFECT' AS PART OF AN INTERVENTIONAL STRATEGY TO CURB OVERWEIGHT AND OBESITY AMONG YOUNG ADULTS IN SUNGAI PETANI, KEDAH, MALAYSIA

ABSTRACT

Overweight and obesity are defined as 'conditions characterized by excess body fat with negative health consequences'. The numbers of overweight and obese individuals are on the rise in Malaysia, despite numerous attempts by means of public health campaigns. This epidemic has affected a very high number of young adults, aged between 18 to 30 years old. Interventions aimed at educating the public about the negative health impact of being overweight and/or obese were not entirely successful in combating this issue. This exploratory, prospective, and descriptive study was conducted among a representative sample of overweight and obese individuals in Sungai Petani. The main objective of this study was to explore the feasibility of utilizing a new technique called 'spacing effect or spaced repetition' technique as part of the interventional strategy in curbing the issue of overweight and obesity. The study consisted of three phases with an intervening gap of six months between each phase. The study instruments used were a pre-validated, customized questionnaire to assess the respondents' scores in three domains (knowledge, dietary habits, and physical activities); and an educational pamphlet to provide information regarding the three domains in order to improve the respondents' knowledge. A change in the scores pertaining to each domain would be reflected by the decrease in weight and BMI of the representative sample. During the initial phase, 115 representative males and 450 representative

females participated in this study. The respondents' weight, BMI, knowledge, dietary habits and physical activities did improve significantly during the course of the study. By the end of phase 3 (P3), the weight (median) dropped by 7 kgs, with a corresponding decrease in BMI from 26.67 in phase 1 (P1) to 24.24 in P3 among the respondents. The respondents' scores in all the domains also increased significantly. The percentage values revealed lowered weight and BMI, and improvement in all the three domains assessed. On comparing between P3 and P1, the percentage value improvement in, knowledge, dietary habits, physical activities, total score, weight, and BMI were 35.0, 43.33, 17.85, 35.71, 10.0, and 9.11 respectively. The score grades of the respondents for the same parameters also showed an increase in 'moderate' and 'good' grades in phase 2 (P2), an increase in 'good' grades in P3, while the number of 'poor' grades which were high during the baseline study dropped markedly at the conclusion of P3. In conclusion, the results showed that it is feasible to use spacing effect technique to improve the knowledge, which in turn positively impacted the dietary habits, physical activities, weight and BMI of the respondents.

CHAPTER ONE: INTRODUCTION

1.1 Overweight and obesity

Weight that is higher than what is considered as a healthy weight for a given height is described as overweight or obese. A high Body Mass Index (BMI) can be an indicator of high body fatness. Overweight is defined as having 'a BMI in the range 25.0 to 29.99'. Obesity is defined as having 'a BMI equal to or in excess of 30 kg/m^2 (Obesity, 2012; CDC, 2017). Both overweight and obesity have the feature of 'excess body fat with negative health consequences', and is a serious public health concern worldwide (National Heart, Lung, and Blood Institute 1998; WHO, 2017). Overweight and obesity are collectively defined as 'processes characterized by excessive accumulation of body fat with multiple organ-specific consequences that could vitiate health' (Network, S.I.G., 2010; WHO, 2016). For adults, the World Health Organization (WHO) defines overweight as 'a Body Mass Index greater than or equal to 25'; and obesity as 'a Body Mass Index greater than or equal to 30'. The BMI provides the most useful population-level measure of overweight and obesity as it is the same for both the genders, and for all ages of adults (WHO, 2017).

Overweight and obesity, caused mainly by unhealthy lifestyles and genetic predisposition, have become pandemic (Swinburn et al., 2011). The incidences of overweight and obesity throughout the world has increased exponentially in the past few decades, the worrying aspect of which is its prominence among children (< 12 years), adolescents (12 – 18 years) and young adults (> 18 years) alike **(**Amin et al., 2015; Kautiainen 2005; Lobstein et al., 2004; Ng, et al., 2014; WHO Consultation on Obesity, 2000). The worldwide prevalence of overweight and obesity has doubled since 1980. Globally, more than 1.9 billion people are overweight, and 600 million are obese. The World Health Organization has largely blamed increased energy intake

of dense foods and physical inactivity for increased weight gain over the years (WHO, 2016).

1.2 Potential causes of overweight and obesity

There are many potential causes of obesity, one of which is the increased consumption of calorically dense, nutritionally void fast food (Fortuna, 2012). The WHO (2016) has largely blamed increased energy intake of dense foods and physical inactivity as the main reasons for increased weight gain over the years. Although increased food intake and physical inactivity does result in weight gain, weight gain is far more covert, complicated, and misunderstood. Weight management is a complex and covert interplay between biology, psychology, and environment, and health professionals need to have awareness with regard to this relationship (Brownell, 2010; Moffitt et al., 2015). According to Pomeranz and Brownell (2008), 42% of regular diners at fast food restaurants eat fast food twelve or more times per month (Pomeranz & Brownell, 2008). Even more troubling are the locations of many of these fast food restaurants, which are often situated nearby people's homes and/or workplaces (Chriqui et al., 2008; Fleischhacker, et al., 2011). Though fast food may be a contributor to obesity, it is by no means the sole incriminating factor. Among the many potential causes are the nutritionally void foods that are high in fat and sugar, a biological disposition to overeat, social norms that promote overeating, low levels of physical activity, and time constraints (Katzmarzyk, 2010; Lee, et al., 2010). The relationship between physical activity and obesity is a convoluted case. It is a general notion that low physical activity levels are associated with body weight gain over time (Hill, & Melanson, 1999; Katzmarzyk, 2010; Nelson, et al., 2007). There is evidence

of increased risk of obesity-related diseases among Asians from BMI 23 itself (James, 2008; Zheng, et al., 2011).

1.3 Consequences of overweight and obesity

The plausible detrimental physical consequences of overweight and obesity comprise dyslipidaemia, hypertension, dyspnoea, impaired glucose tolerance, hepatic and renal issues, among others, which are precursors to highly precarious cardiovascular risk factors. These issues gradually turn conspicuous as an individual passes through the various life stages from childhood to adolescent to young adult stage (Baker et al., 2007; Bjorge et al., 2008; Biro et al., 2010). Excess body fat, especially abdominal fat, increases the risk of many conditions, including insulin resistance and Type-II diabetes. Obesity is recognized as a multi-factorial disease resulting from the interplay between genetic factors and lifestyle influences including diet and physical activity habits (Guelinckx et al., 2010; Locke et al., 2015; National Heart, Lung, and Blood Institute 1998).

The WHO cited the issue of 'tracking' as the most paramount protracted repercussion of overweight and obesity in childhood. Tracking is the 'persistence of overweight and obesity from childhood into adulthood, with all the associated risks and hazards' (WHO Consultation on Obesity, 2000). The prospect of obesity lingering into adulthood increases with the severity and onset age. Obesity during adolescence is affiliated with increased mortality and morbidity in adulthood, even if the BMI is normal (Biro et al., 2010; Engeland et al., 2004; Must et al., 1992; Reilly & Kelly, 2011). Elevated BMI is directly related to premature death, cardiovascular diseases, diabetes, musculoskeletal disorders, and cancers (Lenz et al., 2009; WHO, 2016). The obesity-

related encumbrance for society is substantial as well. Estimations of economic costs incurred range from 2 – 7% of total health care costs, which imply obesity represents one of the largest expenditures in health care budgets (Bhattacharya, & Sood, 2011; Chou et al., 2004; Seidell, 1995; Wolf & Colditz, 1996, 1998; Swinburn et al., 1997; Tsai et al., 2011). In the year 2003 itself, the global burden of overweight (BMI=25.0) and obesity (BMI=30.0) was estimated to involve 1.7 billion people (Deitel, 2003).

1.4 Malaysian Scenario

Overweight and obesity are insidious disorders blighting the Malaysian population. There are numerous studies affirming this reality. This issue has been prevalent in the Malaysian population for a prolonged time period, as some of the studies attest (Balkish et al., 2013; Bong & Safurah, 1996; Ismail et al., 2002; Khambalia & Seen, 2010; Ng et al., 2014; Sivashanmugham et al., 2017). In the context of the current scenario, Malaysians in general, have not reaped benefits from the impact of globalization and industrialization. Once considered an urban menace, nutrition-related chronic degenerative diseases have now disseminated to the rural population at alarming rates. In 1996, the National Health and Morbidity Survey (NHMS) reported 15.1% of adult males were overweight and 2.9% obese, while 17.9% and 5.7% adult females were overweight and obese respectively. The report also stated that there existed very negligible differences between rural and urban populations, the Malays and Indians had higher incidences as compared to the Chinese (NHMS, 1996).

The NHMS Report 2015 revealed that 33.4% and 30.6% of a representative Malaysian young adults' population were overweight and obese respectively. 25.3% of the population had BMI in the range 27.5 – 34.9 kg/m^2. The NHMS Report 2015 showed that the national prevalence of overweight, obesity and abdominal obesity had increased

by 0.6%, 2.6% and 2.0% respectively, as compared to the previous findings of NHMS 2011(The NHMS Report, 2015 vol.2).

The co-morbidities of obesity engender (give rise to) increasing financial costs to the health economy of many developed countries. Similar demands in Malaysia will inflict a huge burden on the human and economic resources and are liable to disturb priorities in the health care or other sectors (Ismail et al., 2002; Chan et al., 2015; Tan et al., 2011).

As Malaysia proceeds rapidly towards the status of developed economy, there is a necessity to develop a national strategy to tackle both dietary and activity contributors to the excess weight gain of the population (Ismail et al., 2002; Rampal et al., 2007). As the number of overweight and obese people increase, the nation is now facing an upward surge of non-communicable diseases such as diabetes and cardiovascular diseases. The overweight and obese Malaysian population are more prone to disease conditions like hypertension, coronary heart diseases, cancers and certain non-communicable diseases (NHMS, 2015; Mohamud et al., 2011; Muzaffar et al., 2012; Ramachandran & Snehalatha, 2010; WHO, 1990).The alarming trend of this issue in Malaysia does not only require immediate revision of public health policies, but also to provide supportive environment and communities for Malaysians to work towards practising healthier lifestyle (The NHMS Report, 2015 vol.2).

1.5 Combating overweight and obesity

The need for prevention is imperative to mitigate the deleterious outcomes due to overweight and obesity (Jensen et al., 2014; Kumanyika et al., 2002; Swinburn et al., 2005; WHO Consultation on Obesity, 2000).

Hurdles in treating overweight and obesity, and retaining weight loss are well-documented. Prevention, not cure, seems to be the most fundamental maxim to overcome this global epidemic (Bouchard, 1996; Gill, 1997; Lau et al., 2007). However, interventions aimed at prevention of obesity or weight gain are scarce, and very few studies have been done (Crawford, 2002; Glenny et al., 1997; Hardeman et al., 2000; Jensen et al., 2014; Lemmens et al., 2008). The nominal data on successful strategies in combating these issues poses an immense challenge in the crusade against overweight and obesity (Canoy & Buchan, 2007). Thus, limited information is accessible for formulating effective obesity prevention strategies.

For planning and effective implementation of prevention policies, additional erudition (having knowledge) is needed regarding the factors attributed to this spiraling issue. Monitoring BMI changes and the pervasiveness of overweight and obesity over time are crucial for evaluating strategies and actions for the effective prevention and management of obesity (James, 1995; Penman & Johnson, 2006).

1.6 Interventional strategies to curb overweight and obesity

The WHO (2016) stated that in order to curb the overweight and obesity epidemic, a population-based multi-sectoral, multi-disciplinary, and culturally relevant approach is needed. Even still, few weight management treatment interventions have targeted the cause of over-eating, maladaptive health behaviors, psychological and emotional barriers, lack of exercise, societal influences, poor self-esteem, social support, and difficulties with adherence and lifestyle (WHO, 2016). Failure to address the roles of psychological and behavioral factors in weight management, may have contributed to numerous failed weight management interventions. (Montesi et al., 2016; Popkess-Vawter & Kramer-Jackman, 2011).

The WHO (2016) has implicated increased energy intake of dense foods and physical inactivity for increased weight gain over the years. Although increased food intake and physical inactivity does result in weight gain, weight gain is far more covert, complicated, and misunderstood. Weight management is a complex and covert interplay between biology, psychology, and environment, and health professionals need to draw awareness and discussion to this relationship (Brownell, 2010; Moffitt et al., 2015). The majority of weight management treatments have demonstrated high prevalence of weight relapse after weight loss, and failed long-term efficacy after diverse healthcare treatments (Dombrowski et al., 2012; Moffitt et al., 2015; Munsch, et al., 2012). These findings postulate that a viable component to curb overweight and obesity, and to maintain a healthy weight is lacking in the interventional strategies utilized so far.

1.7 Behavioral Modification

Several health behavior theories and models have been used in the development and implementation of dietary and physical activity interventions (Kegler et al., 2014; Kunin-Batson et al., 2015; Lake et al., 2009). Behavioral factors are inextricably linked with poor food environments to influence excess weight accumulation (Racette et al., 2003). Many health organizations and scientific studies have aimed to hypothesize a specific cause for overweight and obesity, and the current poor success rate of interventional programmes for weight management. A combination of sedentary behavior, less healthy eating patterns and low physical activity has implications for the long-term health of individuals (Kegler et al., 2014; Kunin-Batson et al., 2015).

A multi-component interventional strategy that fosters healthy behaviors by conducive approaches can be successful in combating the overweight and obesity

pandemic (Kirk et al., 2012). Targeting both the environmental and individual determinants of overweight and obesity demonstrate better long-term efficacy (Linde et al., 2012). One such strategy is the spacing effect, a memory advantage that occurs when learning is distributed across time instead of being crammed into a single session of information exposure (Sobel et al., 2011). The spacing effect is the observation that repetitions of information spaced in time tend to produce stronger memories than repetitions massed closer together in time. Spacing not only benefits the learning and retention of specific items, but also improves the generalization of absorbing and retaining information. (Smolen et al., 2016).

1.7.1 The KAP Score model

A well-known theory of behaviour change depicts how an individual travels towards change in behaviour through a progression of stages. The procedure begins with awareness and knowledge-building, proceeding onward to trust development and mentality change to behavioural intention and change that inspires altered practice (Figure 1.1).

Figure 1.1: The KAP Score model (that approximates the behavioural change of an individual).

In light of this hypothesis, the Rapid Asia utilized a demonstrated model (KAP Score model) that could presume the behaviour change and recognize the phase at which a recipient is, at any given time point. (Rapid Asia is an organization which specializes in Monitoring and Evaluation (M&E) of social development projects and has extensive experience in consulting projects on M&E, both in terms of design and delivery). A lone intervention can rarely move a recipient through every one of the stages; however it can make a commitment by moving them to a more elevated level in the path towards behaviour change, and improves the probability to do so (KAP Score, Rapid Asia, 2016).

This study targets the core, grassroots level of the behavioural model, which in the context of this research represents the overweight and obese individuals (Figure 1.2) to provide a sustained and long standing positive outcome. The aim is to increase knowledge which will in-turn influence each individual's practice (i.e., dietary habits and physical activities).

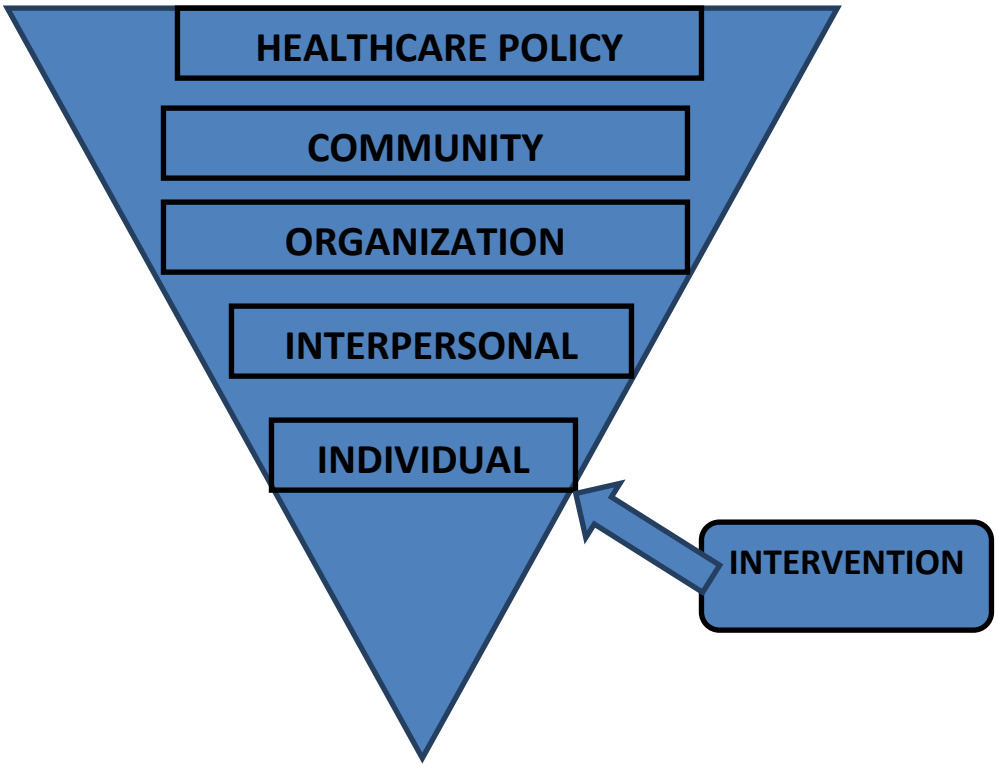

Figure 1.2: Ecological health promotion model

The health belief model proposes the probability of individuals making a move to a health-related issue depending on their vulnerability to the health issue in question, their conviction about potential results, their conviction that a specific plan (intervention) will decrease the likely negative outcomes (Janz & Becker, 1984; Davies & Macdowall, 2005).

1.8 Spacing Effect: What Is It?

For over a century, it was recognized that learning and/or memory is enhanced when 'the same information is repeatedly distributed over time when compared with the same amount of information massed together in time' (Ebbinghaus, 1885). The 'distribution of practice' (McGaugh, 1966) or 'the spacing effect' has been demonstrated in a variety of learning models. The learning advantage of information that is repeated in a spaced fashion is called 'Spacing Effect'. Spacing effect focuses on spaced repetition of, or exposure to an

ideology or concept. The spacing effect was confirmed in many different memory tasks such as recognition, frequency estimation, free recall and cued recall (The Spacing Effect). Having the initial study (or exposure to the information) and subsequent exposure or review spaced out over time generally leads to superior learning than having the repetition(s) occur in close temporal succession. This phenomenon is called the *spacing effect* (sometimes also referred to as spaced repetition or distributed practice). The optimal duration of spaced exposures varies across studies and has ranged anywhere from a few seconds (Carpenter & DeLosh, 2005) to several weeks (Cepeda et al., 2008) to several months (Sobel et al., 2011).

Repetitions of an experience farther apart in time will have greater effect in improving memory than repetitions close together in time (massed practice). Spacing effect focuses on spaced repetition of, or exposure to an ideology or concept. The spacing effect is a powerful and well-documented effect on memory. It is robust, meaning (a) it applies to many situations and types of learning, and (b) it is dependable. Hundreds of experiments on the spacing effect reveal a simple underlying principle. The closer you are to forgetting something, the more a fresh exposure to it helps. A general concept is that a repetition will help most if the material (information) had been in storage long enough to be just on the verge of being forgotten (Banaji & Crowder, 1989; Kerfoot et al., 2007).

As time progresses, people lose their ability to recall past experiences. The amount of information lost per unit of time gradually shrinks, producing the well-known increasingly gradual forgetting curve. Far less is known about the course of forgetting after a person has experienced multiple exposures to the same piece of information. Multiple exposures are obviously very common, and are probably essential for most long-term instruction. Thus, an understanding of how the gap between few exposures affects subsequent forgetting is

fundamentally important if one wishes to temporally structure learning events in a rational manner. Taking the effects of the gap into account could yield important benefits if it turns out that these effects are large. Effects of the gap between exposures on later memory are usually termed ‘Spaced Repetition’ or ‘Spacing effects’ or ‘Distributed-practice’. Study-phase retrieval theory posits that repetition of an item retrieves one's memories of the repeated item's earlier occurrences and their associated contexts (Siegel & Kahana, 2014). This retrieved information, in turn, becomes associated with the repeated item, thus providing an additional set of retrieval cues for the repetition. Retrieved context models have been applied to a wide range of recall phenomena involving recall of once-presented items (Gershman et al., 2012; Sederberg et al., 2011; Shankar & Howard, 2012). Repeated encounters with the learning material that are spaced out in time (as opposed to recurring back-to-back) are an effective way to foster learning that is long lasting. Incorporating spaced repetitions into existing educational practice is feasible and has great potential to produce gains to learning and improving knowledge (Sean, 2016).

A spacing experiment should involve multiple periods of ‘study’ or ‘exposure’ devoted to the same material (information), separated by some variable time gap, with a final memory test administered after an additional retention interval (RI) measured from the second exposure to the same information (Fig.1.3). No gap between the periods or phases results in worse final test performance than does a brief gap (Cepeda et al, 2008).

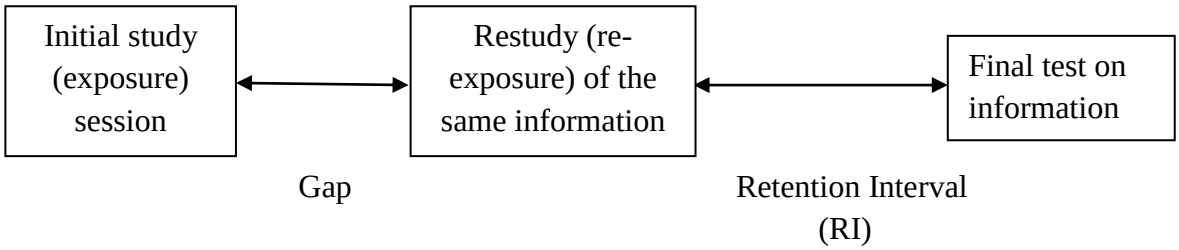

Figure 1.3: Structure of a typical spacing effect (on learning and information retention).

Study episodes are separated by a fixed gap, and the final study episode and test are separated by a fixed Retention Interval (RI).

A number of theories may explain the benefit of spaced practice for long-term retention (Toppino & Gerbier, 2014). According to one prominent theory, repeating an item potentially reminds the learner of its prior occurrence, which prompts retrieving the previous presentation of the item, a process that enhances memory (Wahlheim et al., 2014). Massed repetition eliminates the retrieval process—there is no need to retrieve from memory because the same item was just presented. Another theory emphasizes the study/learning context (i.e., what surrounds an event, from the external environment to an individual's mental state). With spaced repetitions, the context that gets encoded in memory with each presentation of an item is likely to be more variable (compared with massed repetitions that are close together in time and context); the variable contexts that are stored in memory then serve as more effective cues for subsequent retrieval of the item (Glenberg, 1979). The different theories are not mutually exclusive, and multiple mechanisms may act concordantly to yield the memory advantage produced by spaced practice.

There must be some underlying mechanism involving the basic operations of nerve cells, because the spacing effect works with all species, not just humans rehearsing verbal material. But for students who are studying, there is a reason why spaced repetitions may be beneficial. They focus attention on weakly learned material. A second study session allows

special emphasis to be put on information that was not well learned in the first study session. In a single session one never finds out which material is easily forgotten (Toppino & Gerbier, 2014).

The learning advantage of information that is repeated in a spaced fashion is called 'Spacing Effect'. The design of a typical study on the spacing effect is illustrated in Figure-1.4. This design includes: (a) At least two study sessions that involve exposure to the same information, (b) A final test over the information, (c) a period of time, referred to here as the spacing gap, that separates the two study sessions, and (d) Another period of time, referred to here as the test delay, that separates the last study session from the final test. In the most basic experimental designs, the test delay is usually fixed (e.g., twenty minutes), and the spacing gap is manipulated. When the spacing gap is set at zero such that two exposures of the same information occur immediately (i.e., the same vocabulary term is repeated back-to-back), the exposures are said to be massed. When the spacing gap is greater than zero such that the two exposures are separated by some amount of time, the exposures are said to be spaced. The duration of spaced exposures varies across studies and has ranged anywhere from a few seconds (Carpenter & DeLosh, 2005) to several weeks (Cepeda et al., 2008).

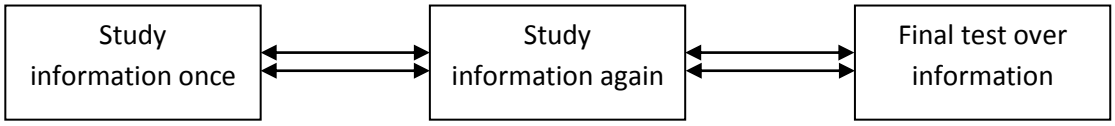

Figure 1.4: Illustration of a typical concept of the spacing effect.

Regardless of the exact value of the spacing gap, spaced repetitions typically yield better learning than massed repetitions. The modus operandi of the spaced repetition effect is as follows: Individuals are exposed to information at least twice, with each exposure

separated by a spacing gap that can range anywhere from zero (i.e., the same information is repeated back-to-back), all the way to several weeks. Retention on the final test is typically better following a spacing gap greater than zero (i.e., spaced) compared to a spacing gap of zero (i.e., massed) (Cepeda et al., 2008).

The spacing effect has been documented in some published studies over the last century (Cepeda et al., 2006; Delaney et al., 2010). The majority of these studies have been conducted in the laboratory involving adult participants who demonstrate benefits of spacing over relatively brief time intervals of less than one day. Other studies demonstrate benefits of spacing in more diverse populations such as young children (Rea & Modigliani, 1985) and older adults (Balota et al., 1989). Numerous experiments by cognitive psychologists have demonstrated the advantage of spaced/distributed over massed practice (Cepeda et al., 2006), and a comprehensive review of the utility of various learning strategies accorded distributed practice one of the highest ratings based on the available research evidence (Dunlosky et al., 2013).

Two predominant types of theories account for explaining the spacing effect. The first is contextual or encoding variability theories (Pashler et al., 2009; Maddox, 2016). These theories suggest that spaced repetitions lead to a greater variety of contextual elements being integrated into a memory than massed repetitions, and a greater variety of contextual elements means that the memory is more likely to be recalled after a delay period. Modern contextual variability theories also have a study phase retrieval component, whereby the original memory or experience must be recalled during the repetition to integrate additional contextual elements and therefore benefit from the repetition (Kelley & Whatson, 2013; Maddox, 2016). Furthermore, these theories suggest that recall is based on the match

between the test context and the contextual elements integrated during the first presentation and repetitions (Batson et al., 2015; Lake et al., 2009). Repeating an item potentially reminds the learner (respondent) of its prior occurrence, which prompts retrieving the previous presentation of the item, a process that enhances memory. With spaced repetitions, the context (information) that gets encoded in memory with each presentation of an item or information is stored in the respondents' memory, which then serve as more effective cues for subsequent retrieval of the item (Wahlheim et al., 2014).

1.9 Rationale of the Study

The proportion of overweight and obesity cases are on the increase in Malaysia (Chan et al., 2015; Chan et al., 2017; Lim, 2016; Mohamud, et al., 2011). Lifestyle changes can contribute to risk factors development of Non-Communicable Diseases (NCDs) like hyperlipidemia, diabetes, hypertension, obesity and overweight. One of the important NCD risk factor is obesity. Weight gain is implicated in the pathophysiology of diabetes, cancers, hypertension and cardiovascular diseases (Abdulla et al., 2008; Calza et al., 2008; Costa-Font et al., 2005; Guh et al., 2009; Lee et al., 2012). Overweight and obesity can lead to increased disability, mortality and rising treatment costs (Popkin et al., 2006). The number of deaths attributed to overweight and obesity worldwide is 300-587,000 annually. Obesity is the second important preventable cause of death worldwide (Dudek et al., 2006; Kivimaki et al., 2017). Poor dietary habits (Niemeier et al., 2006) and lower physical activity levels (Fotheringham et al., 2000) have resulted in an obesogenic environment and subsequently, increased obesity proportions. Prepackaged, convenience meals are often eaten in front of television, computer or video (Davey, 2003). Through the years, occupation-related physical activity has decreased as many earlier manual tasks are substituted by automated machines

resulting in more sedentary jobs (Charlton & Murphy, 1997; Davey, 2003). Many labour-saving devices have contributed to decreased levels of domestic activities. Consumer driven attitudes like owning a car as a status symbol have impacted on the decreased levels of physical activity (Simkhada et al., 2011).

Since the mid-90s, various diet, exercise, behavioural and drugs interventions have been developed and trialled for the prevention and/or treatment of overweight and obesity. In early 2000, these interventions were systematically reviewed to identify effective interventions for treatment of obesity. These reviews revealed only some short-term beneficial effects on many health outcomes, but the evidence for long-term sustainability of these benefits was limited (Anderson et al., 2003; Aucott et al., 2005). Consequently, studies began to suggest that the focus should be on prevention of weight gain to combat the consequences of obesity (Davey et al., 2003; The National Task Force on Prevention and Treatment of Obesity, 1994).

Identifying transition points in the life course and time periods where individuals are at high risk of gaining weight was one of the approaches suggested to help change behaviour in an attempt to prevent obesity (King et al., 1998; Leermaerks et al., 1998; NICE, 2007). Given the limited evidence for successful interventions to treat overweight and obesity, the ideal way forward is to encourage and promote healthier lifestyle. The National Institute for Health and Clinical Excellence (NICE) guidelines on behavioural change highlights that it is important to identify the target population, contextual (barriers/opportunities for change) and social factors that might affect behaviours when planning for any health improvement interventions (NICE, 2007). Majority of the intervention strategies focused on behavioural alteration of diet and exercise. But, these methods have had little impact on the burgeoning

obesity epidemic. These studies recommended that in addition to the alteration of diet and exercise, focusing on improving the knowledge of subjects with regard to overweight and obesity as part of the interventional strategies, could aid in weight loss management (Mahshid et al., 2005).

Interventions aimed at educating and informing the public about the hazards of being overweight and/or obese is one of the best methods to combat this issue. Concise educational pamphlets, Audio Visual (AV) aids specific to the local population will aid in this endeavour. However, it is imperative that the respondents (participants / sample) show sustained improvement in order for better outcomes in terms of knowledge, dietary habits and physical activities, reduction in weight and BMI. Majority of the intervention strategies focused on behavioural alteration of diet and exercise. But, these methods have had little impact on the burgeoning obesity epidemic. In addition to alteration of diet and exercise, focusing on improving the knowledge of subjects with regard to overweight and obesity can aid in weight loss management in interventional strategies (Mahshid et al., 2005). Interventional techniques should not be a one-time event. The recipients of the intervention(s) should be able to retain the information acquired during the initial intervention stage.

The spacing effect (or spaced repetition) technique involves bombarding (reinforcing) the same concept(s) at regularly spaced time periods, in order for the recipients to accrue the benefits of the intervention for prolonged time periods. There is, however, relatively little research on testing and spacing effects in health-related research, including pharmaceutical research. Spaced learning is not often explicitly utilized due to a paucity of research in applied settings (Carpenter et al., 2012). The primary goal of the current study is to determine whether utilizing the spacing effect modality improves the knowledge, dietary

habits and physical activities of the subjects, and to consider whether spacing effect can be a useful modality in curbing overweight and obesity among subjects.

1.10 Problem statement

Malaysia has been witnessing an astronomical increase in the proportion of overweight and obese patients. Despite numerous efforts undertaken by the various healthcare organizations and the Ministry of Health, the percentages of overweight and obese cases still keep on increasing. The National Health and Morbidity Survey 2015 stated that 33.4% of the Malaysian population was overweight, while the national prevalence of obesity was 30.6% (NHMS, 2015). A disturbing fact is that when compared to the previous NHMS report (i.e., in 2011), a 0.6% increase in overweight and 2.6% increase in obesity cases among Malaysians was noted. This is a bleak scenario for the Malaysian population health wise (NHMS, 2015).

Health campaigns, patient counselling and various strategies have not been as successful as envisaged by the healthcare authorities and the Ministry of Health (MoH), Malaysia (Verma et al., 2013). A possible reason could be that as time passes by, the participants of these sessions might not remember the crucial pointers discussed at length during the campaigns and/or counselling sessions. The key to improving the compliance of the respondents would be to repeatedly target them with the same information and important pointers at optimally-spaced lengths of time, a phenomenon called ‘Spacing Effect’, which entails the spaced repetition of information.

This research looks into the feasibility of using spacing effect as an aid in interventional programmes, to improve the outcomes. Specifically in this study, the researcher incorporated the spacing effect modality in the intervention involving the various concepts and important pointers pertaining to knowledge, dietary habits and physical

activities with regard to overweight and obesity in the sample studied. The researcher hypothesized that by employing the technique of spaced repetition, a marked improvement in the overweight and/or obese respondents' knowledge, dietary habits and physical activities would be attained / observed, and this would aid them in reducing weight and maintaining a healthy BMI.

1.11 Research Question

Is the spacing effect interventional technique a feasible modality to cause or prompt an improvement in the domains of knowledge, dietary habits and physical activities of the respondents with regard to overweight and obesity?

1.12 General Objective

1) To utilize the spacing effect (spaced repetition) modality in curbing the issue of overweight and obesity by estimating the changes in knowledge, dietary habits, and physical activities, among the selected representative sample from Sungai Petani district of Kedah Darul Aman state.

1.13 Specific Objectives

1) To measure and assess the weights and corresponding BMI variations of the selected sample during each phase of the study.

2) To measure and compare the scores attained by the study population vis-à-vis each domain and the total score, during each phase of the study.

3) To develop and validate the study questionnaire and educational pamphlet used in this study.

4) To measure and compare the differences between the genders with regard to overweight and obesity during each phase.
5) To measure and assess the association between the ethnicities to overweight and obesity during each phase.
6) To measure and assess the association between location of respondents to overweight and obesity status during each phase.
7) To mmeasure and compare the association between smoking and alcoholic status of the respondents to overweight and obesity during each phase.

1.14 Hypotheses

1.14.1 Research Hypothesis

If spacing effect is a component of interventional education, then the knowledge, dietary habits, and physical activities of the study population with regard to overweight and obesity will improve.

1.14.2 Experimental hypothesis

Ho: The spacing effect (spaced repetition technique) has no impact on the knowledge, dietary habits and physical activities of the respondents with regard to overweight and obesity.

H_1: The spacing effect (spaced repetition technique) has a definitive impact on the knowledge, dietary habits and physical activities of the respondents with regard to overweight and obesity.

1.14.3 Statistical hypothesis

Ho: There is no change in the individual domain scores and the total score between baseline (P1) and subsequent phases (P2 and P3) following the intervention.

H_1: There is a definitive change in the individual domain scores and the total score between baseline (P1) and subsequent phases (P2 and P3) following the intervention.

1.15 Conceptual Framework of the study

An ecological health promotion model was used as a basis for this studies framework, which proposed appropriate knowledge regarding any health care related issues or infectious diseases would influence the participants' perception towards health care which in turn will have a significant change in their dietary habits and physical activities, which ultimately modifies their behaviour towards practice of healthy life style. In 1988, McLeroy developed an ecological model of health promotion to study the patterns of human behaviour. He demonstrated, behaviour is influenced by five individual and environmental factors namely inter-personal and intra-personal factors, primary groups, institutional factors, community factors and public health care policy (McLeroy et al., 1988; Golden & Earp, 2012). Keeping in view the models for behavioural change (discussed under section 1.7) in the study population, a conceptual framework (Figure 1.5) was designed to educate the study participants with the necessary knowledge on overweight, obesity, and key concepts pertaining to it, so that this study could contribute towards the transformation of individuals in their change in attitude and practice thereby reducing the incidence of overweight, obesity, and associated disorders. The conceptual framework of the study is illustrated below (Fig. 1.5). It depicts the various strategies employed to curb overweight and obesity among the